



# Phasing Future Foundations

## Phase 1-a building block for space station technology

(Editor's note: This is the first in a series of articles on the Phase 1 Program. Profiles of astronauts slated for a stay on Mir will follow this overview as their flights approach.)

By Kyle Herring

The United States and Russia have just decided to lengthen the first of the three steps in an approach leading to the development and eventual staffing of a permanent International Space Station.

The longer stride for Phase 1 comes in the form of two additional shuttle-Mir docking missions to be flown in 1998 designed to expand the knowledge of life in space over extended periods.

With the launch in two weeks of the third shuttle docking to Russia's Mir Space Station, NASA and its international partners are finding that Phase 1 is a valuable precursor to learning about all aspects of living and working in low Earth orbit. Phase 1 now consists of nine missions in which the shuttle will link up to the Mir to deliver astronauts as well as logistical supplies and water.

Some of the Phase 1 mission activities that will lead to long-term benefits include rendezvous and proximity operations near a large space structure; the effects of thruster jet firings on those structures and how to minimize or redirect those firings; assembly techniques similar to those that will be used beginning next year on the ISS; and long-duration effects on the human body and how those effects can be studied to benefit people on Earth.

"We are laying the foundation for construction of the International Space Station with these docking flights," said NASA Administrator Daniel S. Goldin. "Mir is proving to be an ideal test site for vital engineering research and expanding our knowledge of the effects of long-duration weightlessness on people."

From a Space Shuttle Program standpoint, that foundation actually began three years ago when Russian Cosmonauts Sergei Krikalev and Vladimir Titov arrived at JSC to train for shuttle flights and to offer the expertise of veteran spacefarers who have lived and worked on long duration space missions aboard Russian space stations.

Krikalev flew on STS-60 in 1994 and Titov on STS-63 a year later. Titov and his crewmates performed a rendezvous with the Mir space station by flying within 37 feet of the laboratory while keeping a continuous verbal communications link with the cosmonauts on board the station.

As the STS-63 crew trained for that first Mir close approach by a shuttle, two veteran astronauts prepared to head to Star City, Russia—home of the cosmonauts. Norm Thagard and Bonnie Dunbar trained as prime and backup crew members for what would be a history-making flight for an American—a launch aboard another country's rocket and a four-month stay on another country's space station.



Thagard's Mir-18 mission began with the launch aboard a Soyuz rocket with cosmonauts Vladimir Dezhurov and Gennady Strekalov a year ago. Following four months of life sciences research, space walks, station module reconfigurations and the arrival of a new Earth-studies laboratory module called Spektr, the crew returned to Earth aboard Atlantis, concluding the longest

space flight by an American and the first shuttle mission to dock with the Mir space station.

Atlantis' STS-71 flight included a crew exchange, dropping off two cosmonauts before returning home. The Mir-19 crew of Anatoly Solovyev and Nikolai Budarin began their mission from Florida aboard Atlantis and returned home to the plains of Kazakhstan aboard the Soyuz capsule left behind by the Mir-18 crew.

The building-block approach to the start of the assembly of the International Space Station next year continued with the launch of Atlantis in the fall of last year on the second docking mission to deliver a Russian-built permanent Docking Module to Mir. This fixture will be used for all future shuttle docking flights providing an extended attachment point for clearance for the shuttle without further reconfiguration of existing science modules on the station.

STS-74 proved the concept of assembling large space components in the microgravity environment of Earth and demonstrated the capability of the shuttle to serve as the cargo vehicle and construction platform for such assembly.

Atlantis has again been processed for launch and sits on Launch Pad 39B at the Kennedy Space Center for the upcoming STS-76 mission in two weeks to deliver the second American astronaut—Shannon Lucid—to Mir for a long-duration stay of about five months.

She will begin a continuous presence of U.S. astronauts aboard Mir for more than two years. Lucid has four previous flights under her belt—STS 51-G in 1985, STS-34 in 1989, STS-43 in 1991, and STS-58 in 1993.

Each subsequent shuttle flight to Mir will exchange U.S. crewmembers, dropping one off during the docked phase of the flight and bringing another home. Next to follow Lucid will be veteran shuttle Commander John Blaha on STS-79 in August. He and Lucid have trained together at Star City for more than a year.

Jerry Linenger will follow Blaha and Mike Foale will replace Linenger. Additional astronauts will be selected to work aboard the space station now that at least two additional flights have been added to Phase 1.

Their training activities are being overseen by a group of people located at Star City, currently headed by Astronaut Charlie Precourt who flew on the first docking mission and will command the sixth.

The two additional flights are STS-89, which had not been previously designated as a Mir mission, and a second mission—a new flight to Mir added to the shuttle manifest—STS-91.

"These additional flights allow more opportunities to refine the operational processes and relationships required by ISS," said Frank Culbertson, acting director of the Phase 1 program. "The flights also supplement the research opportunities during the earliest months of ISS assembly prior to delivery of the U.S. laboratory."

Culbertson added that the two missions will help reduce "the Mir logistics support burden on the Russian launch capability and potentially offload the logistics burden for ISS."

This first step toward the new International Space Station already has demonstrated the ability of the U.S. and Russia to take culturally diverse space programs down the same path. Joined by a

host of international colleagues from the European Space Agency, Canada and Japan, the knowledge base and expertise will continue to phase toward the future.

Phase 1 has provided not only the capability to conduct significant life sciences, rendezvous and assembly work, but to bridge those cultural differences and work together to solve technical problems for the benefit of the ISS program.

"Numerous technical design and operational issues have been uncovered and resolved," Culbertson said. "Learning about the process by which we have accomplished these significant activities is probably one of the most important potential contributions to the ISS program."

"But the most valuable current contribution of Phase 1 is the way it brings U.S. and Russian personnel together in multifaceted scenarios where they are required to work real issues to conclusion and keep the bureaucracy at bay," he added.

As dynamic as the ISS program is, decisions are being made and progress continues. Russia will modify its Soyuz space capsules to

accommodate a larger percentage of the U.S. astronaut corps since the capsule will serve as the emergency return vehicle for crew members living and working on the station through the end of its construction in June 2002. At that time, new NASA-developed vehicles are expected to be available. Size restrictions of the Soyuz capsule currently would prevent nearly half of all U.S. astronauts from being eligible for Russian-based launches to the station.

Russia also will increase the payload-carrying capability of its Progress resupply vehicle by 440 pounds, and will develop a new resupply vehicle, called the FGB cargo vehicle, which would haul maneuvering propellant to the space station.

Launch of the first component of the International Space Station is 20 months away. Astronaut Bill Shepherd and Krikalev will make up two thirds of the first team to occupy the International Space Station six months later. They will be launched aboard a Soyuz rocket from the Baikonur launch site in Kazakhstan.

The International Space Station team is at Phase 1 and counting. □



From left to right, top to bottom: 1) A fish-eye view from the onboard IMAX cameras shows Atlantis completing its docking operations with the Russian Mir Space Station during STS-74. The astronauts successfully attached the docking module to Mir's Kristall module that will serve as the permanent docking port for future shuttle/Mir missions. 2) The first American to live and work on Mir, Cosmonaut/Researcher Norm Thagard, shows off his sleeping accommodations. 3) Oleg Babkov, senior program manager for RSA Energia cuts a Mir 10th anniversary cake in the Teague Auditorium. Babkov with Charlie Lundquist, left, deputy manager for the Launch Package Russian Segment Integrated Product Team One, celebrated the anniversary Feb. 20 during two weeks of technical interchange meetings held at JSC. The group sang 'Happy birthday to Mir' during the celebration. 4) STS-74 Commander Ken Cameron floats into the core module of Mir.

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